SCIENCE

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BAUXITE MINING.

BY HENRY M'CALLEY.

BAUXITE mining in America is a new thing, only a few years old, and hence its methods, etc., are known to but few. Four companies have been engaged in it, viz.: Republic Mining and Manufacturing Company, formerly of Hermitage, Ga., now of Rock Run, Ala., the pioneers in the business; Southern Bauxite Mining and Manufacturing Company, Piedmont, Ala., Georgia Bauxite Company, Linwood, Ga., and the John D. Taylor Bauxite Company, Summerville, Ga. Only the first two of these companies, however, are now actively engaged in the work, the Georgia Bauxite Company having laid off a few months ago until the tariff question is settled, and the Taylor Bauxite Company having never done anything more than to develop the quality and extent of its deposits. The two companies now actively engaged in the work have mines in both Georgia and Alabama, though they both, in 1892, concentrated all of their forces in Alabama, in the "Dyke District," Cherokee County, and so they are not now working their Georgia mines. They each have in the "Dyke District" two mines, though the Southern Bauxite Mining and Manufacturing Company are at present working only one of theirs. These mines consist of nothing more than irregular holes, diggings in the ground, on the sides of hills, with deep, open drainage channels, or ditches, leading off from them and with graded ways leading down into them. In other words, they are the counterparts of limonite and manganese diggings, with the addition of the drainage channels, the ore occurring very much as do the limonites and manganese, in irregular or ill-defined beds or deposits in residual clays. It is, however, more or less stratified, or, in other words, follows the strike and dip of certain strata.

The mining of the ore is made easy by its comparative softness below the surface, being usually soft enough to be dug up with a pick. It is, however, expensive to mine, from the fact that it is so variable in quality that it has to be condensed and assorted. The ore in the same mine often changes from one quality to another, sometimes suddenly and sometimes gradually. It is condensed and assorted by means of the screen and the hand.

The mining implements are of the most simple kind, consisting of only the pick, shovel, churn-drill, wheelbarrow and tram-car. The ore has to be dried before it is shipped, as it has a very great affinity for hydroscopic water. This drying is done at present by simply spreading the ore out over the yard and under the shed; and leaving the rest to the sun and the winds. The preparatory work, therefore, in commencing to mine bauxite consists in leveling off a yard, building a shed, building of a road or track to the dump piles, and the securing of perfect drainage for the mine.

As now conducted, the drying process goes on only during favorable weather, and hence at the expense of much time and often of completeness. This will doubtless be corrected as soon as the profits of the business will admit of the additional outlay of capital for the erection of artificial driers. The present method of mining will, of course, have to be varied some, as the diggings get too deep to be drained by open ditches, and as bedded rocks are struck, provided the deposits still hold out. No bedded rocks as yet, other than the ore itself, have been struck in any of the mines.

The Alabama ores have, up to this time, invariably improved with depth, though, in some of the Georgia mines, the ores have deterioriated, or have increased in iron and silica with depth. The best variety of ore now makes up most of the shipments, and so the inferior ores, though many of them of very good quality, are accumulating at the mines. This is to be regretted very much, especially since nearly all of the present shipments are used for the manufacture of alum, and a much inferior ore, or one much higher in iron and silica, might just as well be used for this purpose. This shipment of only the best ore is, however, a necessity, from the fact that these new enterprises have to meet in competition old and well established shippers of cheap foreign ores. They have been so successful in this competition that they have about killed the import trade. If the shipment of the best ore first was not a necessity it would be nothing more than what might be expected, as it would be simply repeating the history of all new mining enterprises at their very beginning.

The three mines that are now in active operation are known as the "Washer or Taylor Bank," "Dyke or Burst-Up Bank" and the "War-Whoop Bank." The first two, on the property of the Bass Furnace Company, are leased and worked by the Republic Mining and Manufacturing Company. The last one is owned and worked by the Southern Bauxite Mining and Manufacturing Company. These mines are in a broken country, from three to four miles to the northeast of Rock Run furnace, to where the ore has to be hauled in wagons to be loaded on the cars. One of these companies employs from fifteen to twenty hands and the other from fifteen to forty, exclusive of the teamsters. This ore now costs, as stated by one of the companies, about $3.45 per long ton, loaded on the cars at Rock Run furnace. The exact cost, however, as stated by this company, is hard to get at, as, the mines being new, a great deal of expense for prospecting and dead work has properly to be taken into account to get the cost per ton. The cost per ton at the different mines would, therefore, probably vary materially from each other.

The "Washer or Taylor Bank or Mine" has now reached a depth at its back or deepest part, next to the hill or ridge, of some forty feet. It will hardly be dug any deeper until there is provided some other means of keeping it dry than the present open ditch. It is proposed to drain it to a still lower depth of some twenty feet by means of a tunnel or drift that will start in some distance away at the foot of the hill. The ore is continuous across the mine in the direction of the strike, a general northeast and southwest direction, though the strike is in waves. The dip, in a general way, is from 30° to 40° toward the northwest. The deposit, however, is irregu-

lar, and little can be known about it until it has been laid bare The ore is about thirty-five feet thick in the mine. It is concretionary or pisolitic and is of very good quality. The upper twenty feet is better ore than the lower fifteen feet, and the best of all is an inter-bedded seam of four to five feet in thickness. An average sample of the mine is said by Mr. John H. Hawkins, superintendent of the Republic Mining and Manufacturing Company, to have about the following analysis:

Alumina	61.00
Ferric oxide	2.20
Silica	2.10
Titanic acid	3.12
Water (Com. and Hydro.) and loss	31.58
	100.00

The "Dyke or Burst-Up Bank" in its back or deepest part is from twenty to twenty-five feet deep. Its ore is divided into two irregular seams by an unctuous clay of white, blue and mottled colors. On the outcrop the ore over the clay is near thirty feet thick, and that under the clay has been dug into to a depth of some twenty feet, though its full thickness cannot be seen. In the mine the ore does not appear to be so thick. The bottom bauxite has in it some spots of bauxitic clay and some streaks of manganese stain. The general strike is to the northeast and southwest, and, in the mine, the dip is near 30° toward the northwest. An average sample of the ore of this mine is said to have about the following analysis:

Alumina	58.21
Ferric oxide	3.60
Silica	2.90
Titanic acid	3.40
Water (Com. and Hydro.)	31.89
	100.00

The "War-whoop Bank," in its back or deepest part, is some twenty feet deep. The different varieties of ore of this mine are known by the commercial names of "War-whoop Ore," "Bird's-eye Ore," "Purple Ore," "War-whoop Bobo Ore" and "Hard White Ore." The "War-whoop Ore" has a putty or dove-colored matrix. The "Bird's-eye Ore" is the "War-whoop Ore" with decomposed matrix; it is inferior in alumina and is so thrown into the waste dump. The "Purple Ore" is "War-whoop" stained, presumably with manganese; it is also thrown over the dump. The "Hard White Ore" has a very white matrix; and the "War-whoop Bobo Ore" is a flour-like ore of about the same composition as the "Hard White Ore." These different ores occur as in the following section, made by Mr. R. S. Perry, general manager of the Southern Bauxite Mining and Manufacturing Company, along a straight line across the mines, commencing with the top ore:

		Feet.
(10)	"War-whoop Ore," about	13
(9)	"Bird's-eye Ore," about	8
(8)	"War-whoop Ore," about	10
(7)	"Purple Ore," nearly	3
(6)	"Clay Horse," a little over	3
(5)	"War-whoop Ore," with 3 inches of (4), nearly	3
(4)	"War-whoop Bobo Ore," nearly	3
(3)	"Hard White Ore," nearly	9
(2)	"War-whoop Bobo Ore," soft, something over	2
(1)	Clay, underbed, white for several feet and then mottled.	

The following analyses are given by Mr. R. S. Perry as the average of those made by the consumers of car-load samples of the "War-whoop" and "Hard White" ores of the "War-whoop Bank or Mine."

	1.	2.
Alumina, from	57.00 to 62.00	56.00 to 62.00
Ferric Oxide	under 1.00	2.50 to 3.00
Silica, about	2.50	5.00
Titanic Acid	3.00 to 4.00	3.00 to 4.00
Water, Combined	29.00 to 30.00	about 30.00
Moisture, Hydroscopic	2.00 to 4.00	3.00 to 4.00

(1) The "Hard White Ore." Average analysis of car load samples of between 500 and 1000 long tons.

(2) The "War-whoop Ore." Average of consumers' analyses.

The company contemplates driving a tunnel from near the bottom of an adjacent ravine under the "War-whoop Bank or Mine." This tunnel would drain the ore to a depth of some forty feet under the present floor of the mine.

The bauxite mining in America, or in Alabama and Georgia, is gradually on the increase, and, unless nipped in the bud by unfavorable legislation, promises to be of no little importance.

A SOUTH AMERICAN LAMPREY.

BY THEO. GILL, WASHINGTON, D. C.

In September, 1867, a lamprey was found in a street of Buenos Ayres and was the cause of much comment, some conjecturing it to have fallen from the heavens (!) and others that it was transported by a water spout. A valuation of 15,000 pesos (dollars) was placed on it, and subsequently it was actually sold for 1,000 pesos. (This was, however, in the much depreciated currency of Argentina.) Later the species was described by Dr. Burmeister as *Petromyzon macrostomus*. In 1882 I ventured to propose for it the generic name *Exomegas*. In 1893 it was re-described and figured by Dr. Carlos Berg, the successor of Dr. Burmeister, as *Geotria macrostomus*. Another specimen was found near Montevideo in 1890, and on it Dr. Berg's communication was based. The description and figure do not, however, entirely agree, and to call attention to such discrepancies is the object of this note. It is to be hoped that Dr Berg will further examine the specimen and elucidate the doubtful points.

From Dr. Berg's illustration, it is evident that the lamprey is not a *Geotria* and that the genus *Exomegas* based on it is perfectly valid. It is not clear, however, what is the character of the annular cartilage, and, from the figure, one might even be excused for thinking it might not be developed. Such want, however, is very improbable.[1] If there should really be no annular cartilage the lamprey so distinguished would have to be referred to an independent family at least.

Dr. Berg says: "*Lamina maxillaris angusta lobulis quattuor valde humilibus fere inermis instructa*," but not the slightest indication of such a corneous lamina is given in the accompanying plate. Only four concentric (not at all diverging) rows of conic teeth are represented as arming the upper half of the oral disk, and one row of numerous (24) teeth is delineated in a marginal lower row. Is there really an upper or suproral lamina, and can the lower teeth possibly be developed from tubercles of the annular cartilage? Dr. Berg says: "*Lamina mandibularis humilissima mutica*." Let us hope that Dr. Berg will dissect the subject sufficiently to inform us, and give us a better illustration. Either the figure of Dr. Berg's memoir is quite inaccurate, or the species deviates remarkably from all other Petromyzonids in dental arrangement. I may add that in common with all others of late years, I have adopted for the family the name *Petromyzontidæ*, for which Professor Agassiz (1850) was responsible. The proper form of the name is *Petromyzonidæ*.

[1] The shape of the mouth sufficiently indicates the existence of an annular cartilage.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

NOTES ON THE GEOLOGY OF THE GOLD FIELD OF CRIPPLE CREEK, COLORADO.

BY H. L. M'CARN, DENVER, COLO.

THE granites surrounding the mineral district of Cripple Creek are of the ordinary types common to the Front Range. They vary from moderately fine to coarse grained in texture. Bedding structure is generally rather indistinct, but in places is strongly marked, and the rock may be more correctly styled gneiss. The quartz in these granites is either of a vitreous translucent or milky variety; the feldspar (orthoclase) usually pink. Biotite is the common mica, but other micas are met with, especially close to the mineral belt; one of these varieties being a black mica with splendent lustre, sub-translucent and dark green by transmitted light. It is strongly iron-bearing, very easily fusible to a black globule and is undoubtedly closely allied to, if not identical with, lepidomelaur.

In the granite ridge bounding the town of Cripple Creek on the west, are seen veins of amorphous, white or rose quartz, often six inches or more in thickness, apparently dispersed without relation to bedding structure, or order of any kind. Similar veins consisting wholly of pink feldspar occur in the same manner. Nests of large tabular prisms of a black mica (lepidomelaur) are also met with. Much of the granite here is of a very coarse texture, the various constituents being often an inch or more in diameter. These veins of quartz and feldspar, the nests of mica, as well as the very coarse textured granites, may all be attributed to a common cause, and have every appearance of having been formed contemporaneously with the consolidation of the containing granite. To the east of this ridge, in the town, as well as in other parts of the district, there occur "endogenous" veins of quartz, associated with parallel veins of feldspar, which are two or three feet in width and may be traced some distance in approximately straight courses. These veins are probably of secondary origin—concretionary veins—due to causes similar to those to which the various alteration belts of rock of the mineral area may be attributed. From the normal granites surrounding the district, towards the centre, occur innumerable phases of altered granitic rocks. Schists, aplites, felstones, conglomerates and breccias abound in numberless varieties, and transition rocks have been observed linking together rocks of very different appearance. Although this region is laid down on Hayden's maps as "eruptive," no true eruptives were seen *in the mineral belt proper*, with the exceptions of a black magnetic dyke in the town, and the rock composing what is known as "Bull Cliffs." These eruptives will be discussed further on. To give distinctive names to the various altered rocks of the district would be as difficult a task as attempting to name the shades from blue to green. Some sort of a classification of the most marked types should, however, be made. The nomenclature in use by the miners is confusing in the extreme and renders an attempted description of the country rock of a mine unintelligible. Granite, schist, porphyry, quartzite and trachyte are the miners' rocks. The term granite is applied to the binary granites as well as to the normal granites, if the rock is coarse-grained and the feldspar still pinkish, but if the feldspar is white, some call it "porphyry," while others speak of it as "quartzite," the choice of terms depending, probably, on their individual preference for the one or the other as a country rock for their claims. These micaless granitic rocks are from course to fine granular in texture—some even passing into a micro-crystalline aggregate. In color they range from white, through bluish-gray and gray, to yellow or brown. Some are pyritous, some mellose, in a fine grained magma, porphyritic crystals or blotches of white feldspar; while others have a leached-out appearance and are often colored yellowish or brownish by iron oxides. Curiously, this last-mentioned type is the one universally called "porphyry" by the miners. It composes the walls of many of the best mines (especially near the surface at depth passing into a grayish, often pyritous felstone) and is a favorite country rock. In the veins it often forms a veinstone, seamed with secondary quartz carrying gold. This so-called "porphyry" is sometimes beautifully zoned with concentric rings of brown or yellow, due to the oxidation outward of iron salts—the rusty bands giving the rock a riband appearance. The interior of such rocks is generally found to be a fine granular, gray material somewhat resembling sandstone, and often containing small grains of white iron pyrites. The micaless granites, where coarse in texture, might be termed "aplites," the fine-grained varieties "felstones." By prefixing descriptive adjectives, such terms as porphyritic gray felstone, pyritous felstone, yellow or brown felstone, etc., etc., would convey some idea of the character of the rock under discussion. There are two distinct mica schists in the camp. In one the mica is a black iron-bearing variety, the rock often appearing to be a disintegrated granite with schistose structure and very friable. This rock is considered an unfavorable country rock. The other schist is a tough, laminated, white rock, the mica being in large leaves of glistening, silvery-white muscovite (or a hydrous alteration variety of muscovite). This latter rock occurs in bands through the heart of the mineral area and in one or two instances was seen apparently bedded with beds of coarse granular, white "aplite" lying conformably upon its dipping surfaces. Some good mines are found in this rock, or rather on its contact with other rocks. The "Bull Cliffs" eruptive is locally called trachyte. The term is not, however, confined to this eruptive, but is given to many dark varieties of rock, of various structure, some of which bear a strong eruptive appearance in hand specimens. Some of these rocks are hard and compact, ring when struck with a hammer, and often contain small grains or prisms of hornblende. These rocks are usually in dark shades of gray and are occasionally exquisitely traced with imitative figures resembling trees, ferns, etc., due, doubtless, to a saturation of the rock with water, which, acting on

the hornblende or irons in the rock, decomposes these minerals. Capillary attraction brings the solution to the surface, where the mineral matter is deposited in the forms mentioned.

Careful examination, wherever exposures showed contacts with other rocks, failed to show any evidence of heat or local metamorphism of any kind. Transition rocks found in the immediate vicinity, as well as in other parts of the district, seem to furnish most of the links between these eruptive appearing rocks and well recognized metamorphic rocks. The absence of visible glassy enclosures, the mode of occurrence, and the fact that intermediate varieties occur, afford evidence that these rocks are simply alteration products of the granites. They might be termed "hornblendic felstones." Types of these rocks have been noticed as patches or masses included in the bedding of alteration granites, where they have the appearance of being due to some concretionary process, whereby they have become segregated into patches more basic than the balance of the formation. Belts of conglomerates and breccias occur in the district, and many good mines are found in such formations. The above mentioned altered granitic rocks comprise the most marked types, but the various varieties graduate one into another by innumerable transitions.

Evidence of bedding is often plainly discernible in these rocks, but stratigraphical study is very difficult owing to the "wash" or "slide" that covers the rocks, sometimes to a depth of sixty or eighty feet. Exposures are rarely to be seen except in the excavations made in prospecting and mining. Some of the belts of altered rock appear to be the upturned edges of regular bedded deposits, but in most cases they seem to be *zones of alteration*, and usually have a more or less northerly and southerly trend. Many of these belts are impregnated with iron pyrites (always to some degree auriferous) and constitute impregnated zones similar to what are termed "fahlbands." The gray pyritous felstones occur in this manner. As before stated, these rocks, especially where they have been leached of their auriferous pyrites and colored brown or yellow by the iron oxides resulting from the decomposition of the pyrites, are the rocks always spoken of in the camp as "porphyry." It is not surprising that the veins occurring in these rocks are so rich in gold, but it must not be understood that it is the only favorable country rock of the district. A number of excellent mines have solid granite walls, and others equally good occur in the various formations heretofore mentioned. The disintegration of the granites has resulted in giving the hills gentle rounded slopes, instead of the cliffs and bold escarpments such as make up the grand, precipitous scenery of Cheyenne Cañon and the other beautiful cañons around Pike's Peak. This disintegration is going on at the present time in the rocks at a little depth from the surface. In one tunnel on the northwest slope of Bull Mountain, at a depth of perhaps 200 feet, and 400 or 500 feet from the mouth, the micaless granite is found saturated with water. The formation is broken up similarly to what is termed "loose formation," met with near the surface in most mines. The rock is, some of it, so rotten as to fall to pieces in handling, though at rest it looks to be firm, with the feldspar porphyritically developed. Examination shows the feldspar to be kaolinized and soft and the rock very friable. Two or three veins have been cut by this tunnel, and in these veins kaolin seams and earthy oxide of manganese are forming, so that one can see *mineral veins in process of formation*. Gold is found in these seemingly unfinished veins, but where cut by the tunnel, they are understood to be "low grade." It may be well to say here that in this district, as in fact in most mining regions, the richest ore occurs in "shoots" or "courses," and a vein may be opened by shaft, or cut by a tunnel, in a comparatively barren part. Drifting on such a vein will often develop richer ore without, necessarily, any particular change in the outward appearance of the ore. In this event an "ore shoot" has been cut, which may extend longitudinally no great distance, but vertically, or downwards at various inclinations, it may extend to great depths. This characteristic of mineral veins has been the cause of many good mines being abandoned, on account of cutting through an "ore shoot" and "losing the ore."

The broken up condition of the rock in the tunnel above alluded to is probably a result of the disintegration going on, portions of the rock, for some reason, resisting the action of water, etc., better than the other parts, thus leaving angular or rounded fragments unaffected. These fragments become cemented together afterwards by mineral matter from solutions, and thus form conglomerates and breccias, such as are found in the belts heretofore alluded to, as well as in the mineral veins.

The veins of this district are, in most cases, unquestionably, true fissures, and "sheeting" of the country rock parallel to the main fissures is a characteristic of many of them. The fissures seem to diverge from several centres in directions between 45° each way from north and south, and but few veins occur nearer east and west than 45°. Where bedding structure can be discerned, the veins are found to cut the bedding either transversely, or at greater angles from the horizontal than the dip of the beds. The fissures evidently did not remain open to any great width, but sufficient cracks remained to permit the circulation of water through them. Mineral solutions have eaten out the faces of these cracks, and replaced the eroded material with silica and gold in the form of vesicular or crystalline auriferous quartz, together with iron and other vein minerals. Professor Emmons in a valuable paper ("Structural Relations of Ore Deposits," Trans. Am. Inst. of Min. Eng. Vol. XVI.) describes the parallel cracks which often accompany fissure veins as "minor fractures which form the adjacent country rock into parallel plates or sheets." There are many excellent examples of such sheeted fissure veins in the district, and it is largely these quartz-filled parallel cracks that yield the richest ore. In many mines the highest grade ore is the finely divided "screenings" resulting from the breaking up of their quartz seams by the blasts. The "clay partings" are also often rich in gold. Many veins have only one well defined wall—the other being so eaten into by mineral solutions as to alter it into ore. Sometimes both walls are thus altered. A kaolin selvage is often found on the defined wall, and in one mine in particular a "slickenside," composed of limonite, was seen taking the place of the clay selvage on a portion of the nearly vertical foot-wall. This "slickenside" was highly polished and striated, the groovings dipping at an angle of about 30° from the horizontal. Many walls are found hardened and grooved, where a regular "slickenside" was impossible, on account of the absence of the right sort of material necessary for its formation. These phenomena afford evidence of a movement of the walls and grinding action only met with in true fissures.

The veins are often mineralized to a considerable distance into the country rock, making it impossible to measure the width of the vein. In one mine belonging to the "Anaconda Group" the rock was quarried out to

a width or thirty feet or more. This mine is a good example of a great "sheeted" fissure—the sheets or plates varying from a few inches to two or three feet in thickness and separated from each other by nearly vertical quartz seams often rich in gold. There is also in this mine, a rich pay streak of vesicular quartz, wad and kaolin, which perhaps occupies what may be considered the "main fissure." The little quartz seams are the "minor fracture cracks" filled with secondary auriferous quartz, and the "sheets" or "plates" the country rock mineralized and changed into low grade ore. Seams and partings of kaolin (the talc or china-clay of the miners), as well as the selvages referred to, are common. Such seams are often followed downward, through the "slide" or "wash," which is generally the top beds decomposed *in situ*, and lead to good veins in the solid formation. Much of the ore is coated and impregnated with fine, white, auriferous iron-pyrites, associated with graphic tellurium (sylvanite), forming a rich and valuable ore. Some of this sylvanite ore is very beautiful as well as valuable—the surfaces being stained a rich blue verging on purple, by fluoric acid, and glistening with fine silvery white bars of sylvanite.

Few valuable minerals besides gold are found in the district. Silver is very seldom met with—the trifling amounts found in the ore being of no commercial importance. Copper is still rarer. Limonite is met with as a vein stone, and, in two or three instances, as a cap to the lodes. It seems to carry little gold, as a rule. Earthy oxide of manganese (wad) occurs in the veins with kaolin. A quartz peculiar to the district is the granular, sugary, massive quartz, often colored blue or purple by fluoric acid. This rock or ore contains a little orthoclase in grains, and is probably a felstone again altered by the mineral solutions circulating through the veins. In many mines it is rich in gold. Galena is very rare, but it is occasionally seen in the form of very small grains in vein stones. In one mine, fine anglesite crystals are found in geodes in a vein rock containing small grains of galena. They are small, tabular, white crystals of adamantine lustre, and result, doubtless, from the decomposition of the galena. Most of the vein matter is simply altered country rock—the kaolin resulting from the decomposition of the feldspar. The vein quartz is the silica which was separated from the silicate (orthoclase) and held in solution in the alkaline waters at the time of the kaolinization of the fieldspar. The iron and *gold* may have been derived from the iron-bearing micas (perhaps directly in some cases, or from pyrites which were themselves derived from the micas) and held in solution in the same alkaline waters that held the silica. These alkaline waters, circulating through the fissures, impregnated the walls and plates, and filled the cracks with auriferous quartz, together with the other minerals of the solutions. Surface water containing organic matter may have aided in precipitating the minerals. One of the most interesting and peculiar vein-stones here found is the variously colored jasper occurring in considerable quantities in the "Victor Mine" and to some extent in others. In the "Victor" the bright-colored cryptocrystalline jaspers are said to be very rich in gold, while the dark-brown earthy-looking varieties carry little or no value. This is very surprising, but a visitor will find very little of the first named variety "on the dump," while in the ore house he will find men carefully sorting and sacking ore for the smelters, and here he can see large quantities of jasper, some striped in shades of red, white and light brown, all of it going into the ore sacks. Sulphate of baryta (heavy spar) was noticed in one mine—associated with crystals of pyrite. Celestite, tourmaline and a few other interesting minerals occur, but are very rare. The mineral veins are, as a rule, singularly free from minerals valuable only to the mineralogist.

While the Cripple Creek mining district must be considered a typical granitic region, the two isolated eruptives heretofore mentioned are interesting to geologists and petrologists. The Black Dyke traversing the northwestern part of the district is at least thirty feet wide. It is questionable whether it reached the surface at any point, until erosion carried away the overlying granites and schists. Where partially excavated in the town, it lies in a belt of black, friable mica schist, but was not sufficiently uncovered to show the contact on either side. Further northwest on a spur of the granite ridge, which bounds the town on the west, this dyke is seen cutting through the granite, and some local metamorphism is apparent at the contact. Here it seems to have thrown out an arm; or rather, it looks as if, unable to force its way higher, the pressure from below was sufficient to force the granite beds upward a little, forming a space into which the molten or plastic matter found its way horizontally. Underlying this arm or sheet, between it and the granite, is a horizontal vein of white, massive, quartz, six inches in thickness close to the dyke, but gradually widening to two feet or more, forty feet away. The eruptive sheet becomes thinner as the quartz vein grows thicker, so that, taken together, they measure about the same throughout their course. The granite, which doubtless overlaid both, has been eroded away. Some prospector has opened the quartz vein by an open cut to the dyke, and tunneled some feet into the dyke itself. The quartz vein, where covered by the eruptive sheet, is strongly impregnated with copper pyrites, and coated blue and green by copper carbonates. Forty feet from the dyke the eruptive sheet comes to an end, and the quartz becomes white, losing all trace of copper. This is the only place in the district proper where evidence of copper was noticed, and it is clear, in this case, that the copper was derived directly from the eruptive rock. Macroscopically this dyke rock is a basic, compact, almost aphanitic, rock, very dark gray or almost black in color and showing minute, metallic grains disseminated throughout the mass. A polished surface, with the aid of a pocket lens, shows fine feathery flakes of a plagioclase feldspar ; the interstitial spaces being filled with a black or very dark green mineral (amphibole or pyroxene). This rock resists erosion well but weathers brown, slightly, on exposed surfaces. Its age is hypothethical, and microscopical study will be necessary to determine its petrological name.

The eruptive forming "Bull Cliffs" is of an entirely different character, and is known in the camp as "trachyte." It is a micro-crystalline rock containing glassy crystals (sanidine). A part of the deposit contains considerable hornblende in grains and prisms. The upper beds, however, contain little or no hornblende and are of a fine mottled greenish-gray and white appearance. This rock splits into slabs, often as thin as one-eighth of an inch with smooth surfaces. It resists erosion much better than the underlying hornblende-bearing rock. The latter disintegrates readily; exposed surfaces have a hackly appearance, and are spotted white with a decomposition product of the rock. The hackly weathered surfaces are often so friable as to crumble off in handling. Large blocks ring almost like steel when struck with the hammer. Hydrochloric acid eats out a considerable part of the rock (probably the nepheline). This eruptive does not seem to occur as a dyke, but rather as an isolated, massive eruption

of some kind. It is a variety of "phonolite." The writer does not believe that the two eruptives described have any bearing on the origin of the gold of this origin. Fire tests on the "phonolite" failed to reveal a trace of gold, and, as yet, no "pay mines" have been found in close proximity to the Black Dyke. The evidence all seems to point to the granite as the source from which the gold and other vein minerals were derived. Micas have been found by the work of Sandberger and others to contain nearly all the heavy metals (according to Phillips, gold, tellurium and mercury, "from want of the necessary appliances were not sought for" by Sandberger); and it would not be unreasonable to expect that future researches may reveal traces of gold in some of the micas of this region. If this prove to be the case, it would not be difficult to form some conception of the manner in which the different changes, which made up the evolution of great gold veins from granite beds, took place. This paper has attempted to convey some idea of the tremendous alteration and working-over by aqueous agencies, to which the rocks of this region have been subjected. If there is an analogy between this alteration and the occurrence of the gold, the *degree of alteration* would satisfactorily account for the great richness of the deposits, and afford much promise of permanence and value at great depths. The bands or zones of alteration were caused by the action of underground waters. There is no reason to believe that these waters were of a *very high temperature*, but that they were hotter than ordinary surface waters is undoubted. Subterranean waters are waters from the surface which have descended through cracks or by percolation through the porous rocks. As stated by Presturch, "the higher temperature of the waters at great depths would give rise to convection currents which establish a constant removal of the mineral matter in solution from deep-seated sources." The meeting of hot waters from below, charged with solid contents derived from the rocks, with surface waters, would reduce the temperature of the ascending waters; and the precipitating agents brought down by surface waters would bring about the deposition of the mineral matter in the interstitial spaces left by the removal of the matter originally therein. The process would thus be a constant interchange of matter—abstraction and replacement. In this way if minerals or rocks of a different character from those existing near the surface were met with and acted upon by these waters great changes could be produced; but, if the rocks were practically the same to great depths, as is likely the case in this region, the alteration produced would be simply changes in the texture of the rock, and in the proportions of the different constituents. These molecular changes would afford opportunities for the segregation and concentration of minerals, and would account for the concretionary veins of quartz and feldspar, heretofore described, as well as the zones or belts impregnated with auriferous pyrites. The micas of the granites would be acted upon; the iron and gold contained in the mica (if the mica held gold) changed into sulphates in solution, which were in turn reduced by the organic matter brought down by waters from the surface, to metallic sulphides (or the iron to a sulphide holding the gold in a finely divided metallic state), and deposited in the pores of rock already rendered porous as described above.

Accounting for the derivation of the sulphur necessary for the formation of sulphates is the one link missing in the chain of reasoning which makes up the theory of "lateral secretion." The votaries of the "ascension" and "sublimation" hypotheses hold that the sulphur must come from deep-seated sources, but they do not satisfactorily explain why it should be present at depth and not in the rocks a few thousand feet above. Neither do they tell us whence comes the sulphur in the great sulphide lead, zinc and copper ores of the upper Mississippi lead region. There the ore occurs in chamber deposits or flats in unaltered Silurian limestones; no eruptives of any kind are met with; and, so far as known, no fissures or other connections have existed, or do exist between these beds and the rocks underlying them at depth.

The atmosphere seems to have been, so far as the writer knows, not considered as a possible source from which the sulphur required for these reactions may have been derived. The carbon necessary for the formation of coal was derived from the atmosphere, and most geologists hold that the air must have contained a larger amount of carbonic acid at the beginning of the Carboniferous period than at the present time. Much sulphur is often present in coal. Is it unreasonable to conjecture that, during those early periods, the air contained gases which are no longer present, or only present in infinitessimal quantities? Great difficulty has always attended analyses of air, but the examination of rain water has thrown much light on the impurities contained in the atmosphere. Geikie says: "Nitric acid sometimes occurs in marked proportions—sulphuric acid likewise occurs, especially in the rain of towns and manufacturing districts. Sulphates of the alkalies and alkaline earths have been detected in rain." He attributes the disintegration of mortar in walls to the action of nitric and sulphuric acids of the air and says: "The mortar of walls may often be observed to be slowly swelling out and dropping off, owing to the conversion of the lime into sulphate." The Colorado Front Range is believed by geologists to have been raised above the sea, as a long, narrow, northerly and southerly island, at about the close of the Archean era; but not upheaved, into a great mountain range, until the close of the Mesozoic. There was thus ample time for the slowest kinds of chemical and molecular changes to take place in. Atmospheric erosion, during these countless centuries, must have carried away several thousand feet of the top beds. To make up for this waste, it is probable that the land was at times upraised to some extent. These sporadic upliftings would likely be accompanied by more or less disturbance of the strata; fissures would be produced, in the areas of greatest disturbance, which would form channels for the circulation of waters; and thus aid in the alteration of the country rock into the bands or zones heretofore described. It was during this period that the sulphur was probably introduced. Whether it was derived from the air and brought down by surface waters, or from the seas bordering this long island, through infiltration, or introduced from below in some manner, is as yet an unsolved problem. In the formation of these belts of alteration and auriferous pyrites "fahlbands" was the first stage in the genesis of these gold deposits; and "lateral secretion," aided by "ascension," which is a necessary adjunct to the *circulation* of underground waters, seems to account for the first stage, as well as for the more recent one of concentration into veins rich enough to work. At the close of Mesozoic time this long, narrow island, which had, for untold ages, existed as land, was thrown up into a mountain range. It was during the folding and contortion of these rocks, attending their upheaval, that the fissures, since filled with auriferous quartz, were probably formed. Enormous lateral pressure caused these great peaks and anticlinal ridges. A torsional

force acting in conjunction with this lateral pressure, would, as shown by Daubreé, cause fractures to occur on the sides of the folds, in the direction of the axis of elevation, or nearly so. These combined forces would, also, according to Daubreé and Emmons, cause the fractures to occur in more or less parallel groups, and would account for the minor fractures or sheeting structure so characteristic of this district. Most of the metalliferous fissures in the district are thus found on the sides of the anticlinal ridges, more or less parallel to their strike, and cutting the bedding vertically or at a much greater angle than the dip of the beds. When such fissures cut belts of pyritous felstone, it seems to be the invariable rule, that some portions, at least, of their course will be found rich in gold.

Waters containing carbonic acid and other solvents acting on the pyrites and orthoclase would decompose them and carry the iron, gold and silica in solution through the fissures. The iron and silica were precipitated as limonite and vein quartz, but the gold, for some reason, was not evenly deposited with the other minerals, but was segregated into "shoots" or "courses" through the veins, the portions of the veins lying between these "ore shoots" being "low grade" or comparatively barren. It is possible that these "ore shoots" owe their richness to their position in the old channels through which surface waters, containing organic matter, or other precipitants, flowed with greatest freedom.

The brown and yellow felstones, commonly called "porphyry" in the camp, are, as before stated, the pyritous felstones leached of their auriferous pyrites, in the manner described, and colored as they are by iron oxides. Much of the gold in the veins may have been derived by a more direct process from the micas, and did not undergo the intermediate stage of deposition with pyrites in zones of impregnation.

No sign of glacial action is apparent in the district, and no large streams are found in the close vicinity of the mines. The valleys or gulches are synclinal troughs rather than valleys of erosion. The products of surface or atmospheric erosion, *since the formation of the mineral veins*, remain for the most part *in situ*—the lack of transporting agencies, such as glaciers or flooded streams, accounts for the thickness of the "wash" and the comparative absence of alluvial gold in the streams draining the district. Placers occur as often on the *tops of the hills* as in the valleys. Some of the decomposed material from the very summits of the hills has proved so rich in gold as to well pay for transporting in wagons to the stamp mills.

If water for hydralicing was available most of the "wash" would yield rich returns.

No attempt has been made in this paper to describe the many really great mines of the district. The writer has simply endeavored to show the connection or analogy between the alteration of granitic rocks and the occurrence of the mineral in veins. If the cause of the concentration of mineral matter into veins is "lateral secretion," it is evident that the greater the chemical and molecular alteration the country rock has undergone, the greater the richness of the veins will be. If this hypothesis is the true explanation for the origin of the gold, the magnitude of the country rock alteration will easily account for the great richness of the mines so far discovered as well as insure their permanence and future value.

In conclusion the writer desires to say that the area under discussion in these notes includes only the mineral belt in which the present pay mines are located. It embraces about fifteen square miles, and does not include the mountains to the north and west, such as Rhylorite Peak and Mt. Pisgah, which, judging from their appearance at a distance, and the testimony of others, are probably of eruptive origin.

THE SYNTHETICAL POWERS OF MICRO-ORGANISMS—I.

BY O. LOEW, UNIVERSITY OF TOKIO, JAPAN.

AMONG all living organisms the micro organisms, micrococci as well as bacteria, bacilli and spirilli, are especially remarkable by their intensity of chemical activity. Oxydations and decompositions, reductions and synthetical processes are executed on an extensive scale. Numerous organic combinations are easily split up, and under atomic migrations substances of a more solid structure are formed, the products of fermentative actions. And amid this destructive activity, while the fight against easily changeable compounds is raging, there is built up in the interior of the cells the most labile of all combinations, the active albumen, being organized to living protoplasm. And this is done, under favorable conditions, with such rapidity that one cell can yield by growth and continual fission in twenty-four hours more than one trillion of new cells! What an energetic manufacture of living protoplasm, of living cells!

If we consider the destructive and synthetical operations, we must arrive at the conclusion that the former are necessary for carrying on the latter; the former yield not only the forces necessary for the synthetical work, but also the suitable atomic groups. It is certainly a highly interesting question of physiological chemistry to study the relations of the two different directions, and to elucidate which the groups are that serve for the synthetical work. In order to see our way clear we must at first consider the chemical structure of the combinations that can serve as nutrients, we must investigate the causes that bring about the transformation of potential into actual energy, and we must recognize, above all, that the proteids of the living protoplasm are chemically distinct, are different from those of the dead; we must acknowledge that when the labile character of the former changes by atomic migration to a stable one the death of the cells has come.

Nutritive and poisonous qualities are relative conceptions, poisons may become nutrients for bacteria when highly diluted, as phenol or acetic ether, and nutrients may become unfit for nutrition if the concentration reaches certain limits. Small chemical changes may convert a nutritive substance into a poison, and again the poison into an indifferent substance; thus the methan is indifferent, the methylic alcohol a nutrient, the methylic aldehyd a poison and the combination of the latter with bisulfite of sodium again indifferent, and even for a certain kind of bacterium a nutrient.

$$\underbrace{CH_4}_{\text{Methan}} \qquad \underbrace{CH_3\,OH}_{\text{Methyl alcohol}} \qquad \underbrace{CH_2\,O}_{\text{Methylic aldehyde}} \qquad \underbrace{\begin{matrix} CH_2\,OH— \\ SO_3\,Na \end{matrix}}_{\text{Methyl sulfonate of sodium.}}$$

Also the quantity of the produced fungoid matter depends a great deal upon the chemical constitution of the nutrient. Thus I have observed with cultures of mould fungi that tannin or tartaric acid yields only 10/12 per cent of their weight, acetic or succinic acids, however, 14/20 per cent, when nitrogen is present in form of ammonia salts. The more oxygen atoms are contained in a compound the less, naturally, will be the relative production of fungoid substance, but it makes a difference as to whether the oxygen atoms are present in form of carboxyl groups or in form of "alcoholic" hydroxyl groups. The easier a substance is decomposed, the more readily it will be used, and the quicker the development of cells will take place.

What substances then can be used as nutrients, can contribute to the multiplications of cells, *i. e.*, for the formation of more protoplasm, of albuminous matter? As albuminous matter contains carbon, hydrogen, nitrogen, sulfur and oxygen[1], we have to consider principally the questions: Which substances are suitable sources for the carbon, which for the nitrogen, which for the sulfur? Numerous experiments made by Nägeli and myself lead to the following conclusions:

1. As sources of carbon can be used in neutral or weakly alkaline solutions; alcohols, phenols, organic acids, ketones, aldehydes, carbohydrates, ethers and esters, many alkaloids.
2. As sources of nitrogen can serve: Ammonia salts, nitrils, amido acids, amins, ureas, guanidins, alkaloids, nitrates and nitrites.
3. As sources of sulfur can serve: Sulfates, sulfites, hyposulfites, sulfo acids, mercaptans, sulfons.

Now of all these substances, so very different in chemical structure and character, the bacteria can form synthetically the same albuminous matter, the substance of their own protoplasm. There can be no doubt that in all these different cases the same proteids result, otherwise the structure and functions of the kind of bacterium grown in these solutions would change, and new species would be formed with ease, according to the difference in food. Now, if we want to get an insight into this remarkable process, we must at first consider which substances are the fittest sources of carbon, which are neither useful nor poisonous, and which are directly noxious?

In regard to the first question we must draw from numerous observations the following conclusions for most of the non-pathogenic forms of microbes:

1. Hydroxylated acids are better than the corresponding non-hydroxylated ones, *e. g.*, lactic acid, $C_3 H_6, O_3$, is better than propionic acid, $C_3 H_6 O_2$.
2. Polyvalent alcohols are more favorable for the development than the corresponding monovalent ones; for instance, $C_3 H_6 O_3$, glycerin, is better than propylic alcohol, $C_3 H_6 O$.
3. The nutritive quality of the fatty acids and monovalent alcohols decreases with the increase of the number of carbon atoms in the molecules; for instance, acetic acid, $C_2 H_4 O_2$, is better than butyric acid, $C_4 H_8 O_2$; methylic alcohol, $CH_3 OH$, is better than amylic alcohol, $C_5 H_{11} OH$.
4. The entrance of aldehyd or keton groups increases the nutritive qualities: glucose, $C_6 H_{12} O_6$, is better than mannite, $C_6 H_{14} O_6$; acetyl acetic ester is better than acotic ester (in 0.1 per cent solutions).
5. Neither noxious nor nutritive properties have been observed by me with picronitric acid, chloralhydrate, pinakon, ethylendiamin, glyoxal, amidoacetal; very poor nutrients are acetoxim, diacetonamin and maleinic acid.[2] (These substances were applied in neutralized solutions containing 0.1–0.5 per cent). According to B. Meyer also mesaconic, citraconic, paramethyl succinic, dimethyl succinic, and benzoyl succinic acid are incapable to serve as food.[3]
6. The poisonous qualities are determined by the energy with which the labile atom groups of the living protoplasm are attacked; chloroform, phenyl, hydrazin, formic or methylic aldehyd may be mentioned here.

Those observations permit us to draw certain conclusions as to the group useful for synthetical purposes. If methylic alcohol is better than amylic alcohol, then the group serving for synthetical purposes will be, of course, more easily prepared from the former; the same is true for acetic acid compared with butyric acid: we are forced to the conclusion that the group for commencing the synthesis of albuminous matter is a very simple one, with only one atom of carbon, and as methylic alcohol as a saturated compound cannot be used as such, the group in question can only be methylic or formic aldehyd. Neither can acetic acid be used as such; it must be converted into a substance suitable for condensating processes, and this cannot be anything else than formic aldehyd also in this case. If this conclusion be correct, then we understand why substances containing the group CH OH are very favorable for nutriment and increase in their useful qualities with the number of these groups (the polyvalent alcohols, the polyvalent acids). We understand also why such substances are capable to nourish certain bacteria endowed with fermentative properties, even in *absence of air*, while substances without this group can be used as food only in presence of air, oxydation being then necessary to form this group. But how is that conclusion possible, if formic aldehyd is a poison? No doubt this seems an objection of weight; but if we consider how easily the formic aldehyd is changed under condensating influences, and how indifferent simple combinations of this aldehyd are, the objection appears no longer so serious; we must only adopt the view that the formic aldehyd undergoes rapid transformations, and that no molecule formed remains unchanged for a second.

If certain substances, as picronitric acid, chloralhydrate, pinakon, cannot be used as nutrients, we may find the reason in this, that those substances offer too much resistance to the bacteria for the production of formic aldehyd; hence no albuminous matter can be synthetically prepared, the living protoplasm cannot grow, not increase, the formation of new cells becomes impossible. It is also simply explained, why oxalic acid cannot be used as food; it can neither by oxydation nor by splitting yield formic aldehyd. Neither are the salts of formic acid suitable nutrients, the conversion into formic aldehyd being rather difficult. I have observed only one kind of bacterium that is able to grow in diluted (0.5 per cent) solutions of sodium formiate; it occurs in the dust of air and forms reddish pellicles.[4] The conversion of formic acid into formic aldehyd by this microbe might be explained by the following equations:

$$\underbrace{\left.\begin{array}{l}\text{H-CO OH}\\ \text{H-CO OH}\end{array}\right\}}_{\text{2 Mol. formic acid,}} = \underbrace{\left\{\begin{array}{l}\text{CHO}\\ |\\ \text{CO OH}\end{array}\right.}_{\text{glyoxylic acid.}} + H_2O$$

$$\left.\begin{array}{l}\text{CHO}\\ |\\ \text{CO OH}\end{array}\right\} = \underbrace{CH_2O}_{\text{Formic aldehyd.}} + H_2O$$

[4] Centralblatt f. Bacteriologie, 1892, XII., No. 14.

(To be continued.)

—The December election of officers of the Wilson Ornithological Chapter of the Agassiz Association resulted as follows: President, Willard N. Clute, Binghamton, N. Y.; Vice-President, Reuben M. Strong, Oberlin, O.; Secretary, William B. Caulk, Terre Haute, Ind.; Treasurer, Lynds Jones, Oberlin, O. The chapter is in a very flourishing condition, with seventy-three active, four honorary and thirty-one associate members. The past year has been devoted to a special study of the Warblers, and the forthcoming report promises to make a very interesting paper. Any information regarding the chapter will be cheerfully furnished by the secretary.

[1] We leave here the nucleins out of consideration, they contain phosphoric acid in their molecule.

[2] The isomeric fumaric acid is, however, a good nutrient.

[3] I may add that methylamin is a better source of carbon than trimethylamin.

CURRENT NOTES ON CHEMISTRY.—V.

[*Edited by Charles Platt, Ph.D., F. C. S. Lond.*]

EDUCATION OF INDUSTRIAL CHEMISTS.

AMONG the most valuable of the papers presented at the World's Congress of Chemists were those in discussion of industrial chemical education. Any four years' collegiate course in chemistry may graduate an analyst: one who is content to remain forever a laboratory employee grinding out results,—and parenthetically let it here be said, that the young graduate need expect nothing but a "grind" in any laboratory. He may have dreams of research and private study, but a few months' time will dispell these with unpleasant forcibleness. He will find that each day brings a mass of routine work, and chemical analysis rapidly degenerates into mechanical manipulation. We do not say this by way of discouragement; analysts are necessary, and many find here the greatest pleasure in their work, but there is needed, too, another class of workers, not higher in dignity maybe, but different in kind; we mean chemical engineers, or, to use the rather awkward designation, industrial chemists. By this we mean men capable of taking hold of the greater operations of the chemical works, capable to superintend, to construct, to alter and improve machinery, to interpret analytical results and to use them in the refinement of processes; in other words, men to comprehend the process as a whole, not only the chemical reactions but also the mechanical means used in their perfection. It is a simple matter to dissolve, precipitate, filter, and dry, in the laboratory, but how is this to be done when there are thousands of gallons to be handled, and this, too, with the greatest economy of labor, of power, and of time? It is true we have catalogues describing apparatus, etc., but of twenty patterns which is to be adopted? An experiment will cost thousands of dollars, and yet it is only the best, the most suitable type of apparatus which will allow the manufacturer to enter the market with his competitors. More than likely, too, *none* of the apparatus catalogued will exactly answer the conditions, and alterations must be made.

It may be said in truth that the chemical engineers of to-day are born, not made, for while there is a beginning in two or three of our technical schools the ideal course in chemical engineering is still of the future. It might be added, however, that the technical schools are the only places in the country in which to learn chemistry for practical purposes of any kind whatever. The larger universities, even those with elaborate post-graduate courses, are fitting preparation for teaching and scientific research, but not for the industrial laboratory.

REDUCTION OF PHOSPHATES AND THE PREPARATION OF COMMERCIAL FERTILIZERS.

A PRACTICAL process for the reduction of phosphates in which carbonic acid is substituted for the usual mineral acid has been proposed by C. Seybold and F. Heeder, (Deut. landw. Presse, 20, 1883, No. 64). The simplicity and increased applicability of the new process makes it of great interest in the production of fertilizers. The procedure is as follows: The phosphate is finely ground, moistened with water and spread in a chamber heated gradually to 120° C, through which a current of carbonic acid with steam is passed. The successive steps are represented by the formulæ:

$$Ca_3(PO_4)_2 + CO_2 + H_2O = CaCO_3 + 2\,CaHPO_4$$
$$2CaHPO_4 + CO_2 + H_2O = CaCO_3 + CaH_4(PO_4)_2$$

The alkali-calcium phosphates are prepared by the addition of carbonate of potash or soda to the moistened phosphate:

$$2Ca_3(PO_4)_2 + K_2CO_3 + H_2O + CO_2 = 2Ca_2HK(PO_4)_2$$
$$2Ca_2HK(PO_4)_2 + K_2CO_3 + H_2O + CO_2 = 2CaH_2K_2(PO_4)_2$$

The by-products are omitted in the above equations. In the preparation of nitrogenous fertilizers the organic nitrogenous substances (hair, hoof, leather, tanhage, etc.,) are dissolved in alkali carbonates with the addition of lime, or in caustic alkalies alone, and the ground phosphate is placed in this solution and treated as described above. To obtain a nitrogenous fertilizer of the composition of ordinary guano, 500 pounds of nitrogenous refuse is dissolved in 50 parts of carbonate of potash decomposed with heat by 50 parts of caustic lime, and 500 – 600 parts of bone meal are added. In the reduction of bone meal the process is as follows: The material is finely ground and mixed with about half its weight of water and spread in the drying oven. Steam is admitted with the gaseous products of combustion, the temperature being kept at about 60°–80°C. The time of treatment necessary, is reduced when alkali carbonates are used. The end product is regulated by the amount of alkali used, by the temperature of the oven, and by the duration of treatment. Among the advantages claimed for this process are the absence of injurious sulphates and the production of a cheap available phosphate, utilizing heretofore rejected nitrogenous substances.

VOLATILIZATION OF METALS AND OXIDES IN THE ELECTRIC ARC.

M. MOISSAN continues his interesting experiments at high temperatures, and the results are as before almost incredible. Condensation in these present experiments is obtained by the introduction of a copper U-tube, through which a rapid current of cold water is continually passed, immediately above the crucible in the furnace. Asbestos board is placed above the opening through which the U-tube is introduced. Magnesium pyrophosphate in the arc produced by a current of 300 ampères and 65 volts produces a sublimate of magnesium oxide and ordinary phosphorus. Asbestos completely volatilizes in a few minutes under 300 ampères and 75 volts. Copper with 350 ampères and 70 volts volatilizes rapidly and condenses in globules. In contact with the air cupric oxide is formed. Silver readily boils and distils, condensing in globules, or in a gray powder or in aborescent fragments. Platinum melts almost immediately and very soon begins to volatilize, condensing in brilliant globules or in powder. So also aluminum, tin, gold, manganese, iron, uranium, carbon, calcium oxide and magnesium oxide all melt, boil and distil over !

Zirconia heated in an electric arc of 360 ampères and 70 volts rapidly melts and in a few minutes is in rapid ebullition. If the zirconia be mixed with an excess of carbon, a residue of zirconium carbide is left, containing from 4.22 to 5.10 per cent of carbon. If this be fused with excess of zirconia pure zirconium is obtained, Sp. Gr. 4.25, scratching glass and ruby easily. A button of zirconium is also obtained as a residue by fusion of zirconia in the electric arc in absence of an excess of carbon. Silica in an arc of the same intensity melts almost immediately and in a few minutes is in complete ebullition.

NATIVE SODA, WYOMING.

H. PEMBERTON, JR., and G. P. Tucker give analyses of the deposits of sodium sulphate occurring in the dry region of the high Wyoming plateau, near the town of Laramie. The lower and greater portion of these de-

posits, known as the "solid soda," consists of a mass of crystals mixed with a considerable amount of black slime. Analysis shows: $Na_2 SO_4$, 36 per cent; $Ca SO_4$, 1.45 per cent; $Mg Cl_2$, 0.77 per cent; $Na Cl$, 0.21 per cent; $H_2 O$, 46.87 per cent; insoluble residue, 13.86 per cent. The upper part of the deposit from 3–12 inches thick is formed by solution from the upper layers of the lower part, and by subsequent evaporation or cooling of the solution. Calculated as anhydrous, the composition of this upper portion is: $Na_2 SO_4$, 99.73 per cent; $Mg Cl_2$, 0.26 per cent; insoluble matter, trace. The article, however, as prepared at Laramie is said to be not so pure.

Artificial Pyroxenes, Etc.

A contribution to the artificial production of minerals in a general method for the production of anhydrous crystallized silicates is described by Dr. Hermann Traube. The amorphous hydrated silicate is precipitated from a solution of the salt of the metal by the addition of a solution of sodium silicate. The precipitate is heated to a high temperature for several hours with boric acid, and the anhydrous silicate is finally obtained in good crystals. Ebelmen has already prepared the mineral pyroxene by this method, but Dr. Traube extends its application to any of the corresponding metallic salts. For instance, beautiful crystals of zinc bi-silicate, $Zn Si O_3$, are obtained by precipitating the hydrous silicate from a solution of $Zn SO_4$ by addition of sodium silicate. The precipitate is ignited with eight times its weight of fused boric acid and finally the boric acid not volatilized is leached out with water. The crystals of $Zn SiO_3$ occur as transparent prisms with domal terminations. By the same method the mixed silicates of this class may be obtained.

Stereochemistry and Motochemistry.

In view of the recent extended study awarded this comparatively new field in chemistry, historical notes of its earlier conception become of interest. In addition to the hints regarding geometrical arrangement in space offered by Swedenborg, Wenzel, Biot, and some others, we have the same ideas foreshadowed in the writings of Wollaston and Ampère—quoted by Prof. John C. Cain, of Owens College, Manchester, in a recent letter to *Nature*. Wollaston in his paper entitled, "On Super-acid and Sub-acid Salts" (Phil. Trans., Vol. XCVIII, 1808) discusses the constitution of the two oxalates of potash: "When our views are sufficiently extended to enable us to reason with precision concerning the proportions of elementary atoms, we shall find the arithmetical relation alone will not be sufficient to explain their mutual action, and that we shall be obliged to acquire a geometrical conception of their relative arrangement in all the three dimensions of solid extension . . . When the number of one set of particles (combined with one particle) exceeds in the proportion of four to one, then, on the contrary, a stable equilibrium may again take place if the four particles are situated at the angles of the four equilateral triangles composing a regular tetrahedron... It is perhaps too much to hope that the geometrical arrangement of primary particles will ever be perfectly known."

The same idea was developed later by Ampère in his "Letter to Berthollet" (1814), in which he considers the molecules as forming various geometrical figures dependent on the number of atoms contained therein.

Under the designation "Motochemistry" M. E. Molinari has recently discussed the hypothesis that the constitution of compounds is dependent on the intromolecular movements of the atoms in relation to one another, rather than on their relative positions in space. The bonds by which it is customary to represent the union of atoms are taken as expressing the nature of the swing or energy of the atoms with regard to each other.

CONTINENTAL PHENOMENA ILLUSTRATED BY RIPPLE MARKS.

BY RICHARD E. DODGE, CAMBRIDGE, MASS.

A few days ago I saw at Winthrop Beach, Mass., some peculiar features of ripple marks that I thought might be of interest to the readers of *Science*.

Walking along the beach close to low-water mark, I noticed from a considerable distance a large number of peculiar markings upon the surface of the ripple marks, with which the shore was extensively corrugated. The sand of which the ripple marks were composed was very micaceous and much mixed with fine mud, so that it held a large amount of water between the particles. There was also a thin film of water on the surface of the deposits, partially held in position, I suppose, by cohesion. The ripple marks had an amplitude of about eighteen inches, and in the hollows between two adjacent marks the film of water was somewhat thicker than on the sides, so that a shallow basin was thus formed, bearing the same relation to the sloping sides of the ripple marks that the ocean itself bears to the adjacent continents.

After having noted the conditions mentioned above, I saw that the peculiar markings were due to the erosion caused by the water running down the sides of the ripple marks toward the hollows. The seaward sides of the marks were being worn away and dissected by a small river system developed thereon, and the waste thus derived was being deposited in the adjacent hollows. We have thus in these ripple marks, left uncovered by the receding tide, constructional forms similar to what we might expect to see when a warped coastal plain emerges from beneath the ocean.

As we would normally expect on such a constructional surface, we had developed at once a drainage consequent on the slope and structure of the materials of which the slope was composed. The streams, small as they were, followed all the laws of the largest continental streams, at once deepening mouthwards and lengthening headwards toward the divide formed by the crest of the ripple marks. Such small river systems were developed at frequent intervals along the slope of the ripple mark, each one having numerous tributaries and assuming a digitate form so familiar in rivers.

As soon as the small stream reached the level of the half-inch film of water in the basin between the ripple marks, erosion ceased and deposition began. In front of each small stream there was building out into the basin a small delta, but very broad and as deep as was the layer of water. The discharge of the minute fragments of waste from the streams was so rapid that I could watch the growth of the delta with ease and could note the building forward of the frontal slope and the building up of the top slope to the surface of the water, as has been described by Prof. W. M. Davis in his description of the growth of glacial sand plains. We thus had forming a small continental shelf similar to that off the eastern coast of the United States at the present time.

A more careful study of the processes in operation in these basins showed me that at certain places the small streams were developing alluvial terraces and at others building alluvial plains according to whether the stream was over or under-loaded with waste to be carried down

the slope. At one place I found that the crest of a ripple mark was cut by a small transverse channel draining the basin above the mark into the one below. Such a small channel must have been formed by an antecedent stream, that is, one in operation and maintaining its course across the rising fold as it emerged from the ocean. Such a river is the Green River described by Powell.

In a word we seem to have in these small ripple mark basins that I have described an epitome of the destruction of continents, of the formation of the continental shelf and the evolution of geographic form as brought about by subaerial denudation. The erosive work was particularly similar to that of an ordinary river because the water running down the slope was very slight in amount. The rills were not formed, as are ordinary rills, by the flowing back to the ocean of the water held in a considerable hollow of the beach. They were formed by the small amount of water held in the spongy material of the ripple marks and pulled down toward the hollows as the level of the water under the surface lowered with the receding tide. The amount of water thus being less than usual in the formation of rill marks, the process was slower and the result more delicate and more similar to ordinary subaerial erosion.

In was interesting to note that the erosion took place only on the seaward side of the ripple marks and the shoreward sides were left undissected. The reason for this seems to be that the water held in the sands was pulled vertically down by gravitative action and hence was drawn through between the particles of the beach deposit toward the next hollow on the seaward side. In this respect only, as far as I could see, did these small streams differ from the streams on a similar constructional slope in the more consolidated rocks of the continents.

It would seem from this instance and others that have been called to my attention from time to time that nowhere do we have such a chance to study dynamical geology in operation on a small scale as at the sea shore. Apart from the work of the ocean itself there are a large number of things similar to what I have mentioned above that are worthy of careful attention, even though they be small. One thing especially that can be studied to great profit at this time of the year is the shore work of frost and ice. I feel that our ocean shores have not been studied in sufficient detail in the past, and I am sure that no better place can be found to show erosive processes in their entirety than the sea shore at low tide.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Another Rope of Maggots.

The note by Mr. Lynds Jones in *Science* of December 29 recalls a similar observation by myself. I was hastening to a train and observed a rope of maggots, such as is described by Mr. Jones, crossing my path, which I at first took to be the skin of a snake. It was on what is called the Gully Road in Newark, N. J., and the maggots were crossing the path from the gully of the road. I kicked it and noticed that the maggots appeared to be clinging to each other, so that they separated in flakes. I had not time to look, but I presumed that they were moving away from a carcass which had been exhausted. A year later along the same road I noticed in the gully the body of a dog which was being consumed by maggots, but I observed, when the food was exhausted, that they moved down the rocky gully not in a rope, but one by one, and scattered along, slender and emaciated, for a distance of perhaps fifty feet. William Hayes Ward.

New York, Jan. 12, 1894.

Secret Language of Children.

Mr. Oscar Chrisman's article in *Science* of Dec. 1, 1893, recalls to my mind the "Hog Latin" that I and my school-boy companions used to use, and by means of which we were able to carry on conversations which were altogether unintelligible to our parents and teachers.

Our "Hog Latin" was formed by transferring the first consonant sound of a word to the end of the word, and then adding long *a*, as in the words doubt = oubt-da, book = ook-ba, house = ouse-ha.

Long words were sometimes split up into syllables, and these syllables treated as shorter words, as: Language = angla-agegwa, suspect = us-sa-ect-spa. This language was defective in that it did not sufficiently disguise those words which begin with a vowel, as: Are = are-a, either = either-a, any = any-a. We used to get around that by avoiding the word I; using *me* instead, or by placing the accent in the wrong place, as: Either-a, calling it *ee*-thra.

I remember that I learned to use the language in a day or two, and after a short time did not have to stop to think how to make a new word, but was guided by the sound entirely.

A couple of sentences will suffice to explain the language:

Where are you going this morning? *Ere-wha are-a oo-ya oing-ga is-tha orning-ma?*

When this language is spoken rapidly it is difficult for those not in the secret to catch what is said. *En-wha is-tha ang-la–edge-gwa is-a oken-spa apid-ra–e-la it-a is-a iffi-da–ult-ca or-fa ose-tha ot-na in-a e-tha e-sa–et-cra oo-ta atch-ca ot-wha is-a ed-sa.* D. T. Marshall.

Metuchen, N. J.

Notes on Water Lilies, Etc.

J. E. Todd in *Science*, No. 567, mentions a "miniature water lily." Another variety of a very small water lily grows at Hyannis Port, Mass., in a long abandoned mill pond. None other of the numerous ponds in that locality, where water lilies grow abundantly, possesses this small and beautiful variety. The blossom is an exact copy of *Nymphea odorata*, and is but one-half inch in diameter; the leaves also, in shape, color and venation, are like those of *N. odorata*, and are but one and a half inch in full diameter. I did not look up the plant last summer, but had found it for several years before, and will search for it when I return to the shore.

Several notes on "coon-cats," etc., recalled to me a very large black and white tom cat, at Hyannis Port, a notable mouser, having the peculiarity of *double fore feet.* All the feet of this animal are particularly large and strong, and on the outer side of each fore foot grows a second paw more than half as large as the normal one. This cat was a vigorous digger; to effect entrance to a basement under my porch, he dug a large hole at an angle of 45° and about eighteen inches deep, passing under the boarding, and large enough for him to crawl

through, but smaller at the inner opening than the outer. Having entered by this means he seemed unable to increase the hole by digging from the inside upward and could not return as he came. When one hole was blocked up by stones, he dug from the outside another, but could never leave the basement unless the doors were opened for him.

In regard to "late blooming trees," I had a flowering almond which bloomed in April, then again in October, and again in April. It was a young shrub, and grew vigorously. I concluded that the October blooming was provoked by very mild, moist, showery, spring-like weather, which continued long enough to develop the flower buds, and then hasten the growth of the next set of embryo buds, to a point where they were ready for blooming on the return of good growing weather.

J. McNair Wright.

BOOK-REVIEWS.

Handbook of Experiment Station Work. A Popular Digest of the Publications of the Agricultural Experiment Stations in the United States. Bulletin No. 15. Washington, D. C., Office of Experiment Stations, U. S. Department of Agriculture. 1893, 411 p.

As mentioned in its title, this bulletin is a popular digest of the work of the experiment stations of the United States. That such a publication is a useful one and serves a very useful purpose is manifest when it is known that there are fifty-four different stations in the country, some maintained entirely by the general Government, some by the several States. These stations had during the year 1892 no less than $997,244 at their disposal, and of this sum $689,542 was from the national treasury. That the stations have done some good work cannot be denied; but that there has been a large amount of duplication without sufficient justification, and a large amount of useless expenditure also, cannot be denied. The Secretary of Agriculture in his last annual report very properly protests against the charging against the Department of Agriculture the sum of over $700,000 annually when the Department has nothing whatever to say in regard to its disbursment. "No detailed account," he says, "as to how the money has been expended, to whom, or for what it has been paid out, is required. Current rumor in some of the States and Territories, so universal, pronounced, accentuated, and vehement as to have secured great credence, indicates that some of the moneys appropriated for experiment stations have been diverted from legitimate public purposes and turned to those of a personal and not patriotic character." He rightly thinks that if the Department is to be charged with the sum it should have the supervision of its expenditure. There are about 500 persons employed in the different stations, and during 1892 alone there were published fifty-five annual reports and 250 bulletins. With such a mass of literature as this to cope with the necessity of some digest is at once evident.

The first regularly organized station was at Wesleyan University, Middletown, Conn., in 1875; but as a result of the law passed by Congress in 1887, giving $15,000 annually to every station organized, *now* every State and Territory except Montana and Alaska have stations, some States have two, and several have three substations.

The volume under review was originally designed as a part of the exhibit of the World's Fair at Chicago, but it has only recently been issued. The various subjects are arranged alphabetically, and while not pretending to be a manual or encyclopedia of agriculture it will at the same time serve as a ready means of ascertaining what has been done upon many subjects of importance in agriculture. Under each heading there is given a brief notice of the subject and at the end refer-

ences, more or less numerous, to station publications where further information can be secured if desired.

It is of course impossible to refer in detail to all the subjects. A reference to a few will probably be of interest. Under *Chrysanthemum* we read that experiment showed it to be possible to keep pollen of the plant for five days and still retain its vitality. It is observed under *Dandelion*, quite extensively used as "greens" in spring, that it has been studied in Minnesota, and directions are given for cultivating it. Geological work is not extensively carried on, only four geologists being employed, and these being engaged in studying soils. Numerous varieties of grasses are discussed, over ten pages being devoted to them. In a short note upon Leguminosæ numerous references are made to investigations upon root-tubercles. Their value in taking nitrogen from the air and storing it in the soil is considered very great, and it is stated that by growing the tubercle-producing plants and plowing them under they form manure for wheat and other crops requiring considerable nitrogenous material. The article upon *Milk* refers to the value of late researches upon bacteria causing fermentation, souring of cream, etc. Those bacteria causing red milk, ropy milk, etc., can be prevented by cleanliness. Those which are useful in butter and cheese making can be utilized. The aroma of butter has been determined to be due to a specific bacterium, and the ferment produced by this is being used to a certain extent in Germany and Denmark. In the ripening of cream there is a conflict of many varieties of bacteria and the problem has been to separate that one which will give the best results. So, too, with cheese-making. The ripening of cheese is due to the action of micro-organisms. The number of these has been found to be from 25 to 165 millions per ounce. The conclusion reached is that in the future "the butter-maker will separate the cream by the centrifugal machine in as fresh a condition as possible and will add to the cream an artificial ferment consisting of a pure culture of the proper bacteria, and then ripen his cream in the normal manner. The result will be uniformity. The cheese-maker will in like manner inoculate fresh milk with an artificial ferment, and thus be able to control his product. Perhaps he will have a large variety of such ferments, each of which will produce for him a definite quality of cheese. To the dairy interest, therefore, the bacteriologist holds out the hope of uniformity. The time will come when the butter-maker may always make good butter and the cheese-maker will be able in all cases to obtain exactly the kind of ripening that he desires."

Under the head of *Phosphates* there is an interesting account of the different kinds, with analyses of those found in South Carolina and Florida. Perhaps the longest article in the volume is upon the weeds of the United States, nearly 20 pages being devoted to them. A list of the weeds with common and scientific names and station publications where referred to occupies thirteen pages. Finally in an appendix there are given a number of tables of analyses, of feeding stuffs, vegetables, fruits, nuts, commercial fertilizers, farm manures and ash constituents of woods. The volume is, upon the whole, one of the most useful which has ever been issued by the Department of Agriculture.

EXCHANGES.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York]

To exchange.—Works on entomology, botany and palaeontology for works on Indians and archæology. H. Justin Roddy, Millersville, Pa.

For Sale.—A Zertmayer new model U. S. Army Hospital monocular stand, cost $110. H. C. Wells, 151 Broadway, New York.

For Sale or Exchange.—A "Troughton & Simms" bronzed metal sextant, with double-frame platinum and gold vernier; fitted to bronze standard, with balance weights attached and brass adjusting screws, with full set of tubes, both plain and inverting; an artificial horizon and all fittings necessary for observing and rating chronometers. Also the first 10 volumes of "The Forum" bound in twenty volumes (in cloth), together with two unbound volumes. Address W. S. Leavenworth, Ripon, Wisconsin.

I have Michigan shells of the unio, alalus, gibborus, ligamentinus, occideus, plicatus, pustrilorus, rubignorus, verrucosus, margaratana, marginala, rugosa, for fresh water and sea shells of other localities and varieties, copies of *Scientific American* for shells; also a few minerals to exchange. Chas. Miller, jr., 216 Jefferson st., Grand Rapids, Mich.

For Sale or Exchange.—A large number of state and general government scientific reports, Smithsonian contributions and Bulletins Torrey Club, Botanical Gazette and many others. These were obtained in the purchase of a large scientific library and are duplicates. Write for what you want and offer any sum. Mexican Boundary Survey, Torrey's Botany California, Blume's Orchids of India and Japan, and Hooker's Rododendrons of the Sikkim-Himalaya are in the lot. What offers? R. Ellsworth Call, Louisville, Ky.

Skins, with full data, of Ægialites nivosa, Ereunetes occidentalis, Ammodramus beldingi, A. rostratus, Chamæa fasciata henshawi and others from California, for native or foreign skins with full data. A. W. Anthony, 2042 Albatross Street, San Diego, California.

For Sale.—An entirely new analytical balance, made by one of the most celebrated manufacturers; capacity 100 grammes, sensitive to one-twentieth a milligramme. Never been used. Regular price, $83. Will sell for $50 cash. Address, A. P. Nichols, 41 Summer Street, Haverhill, Mass.

Wants.

WANTED.—Vol. Birds of the Standard or Riverside Nat. Hist. Preferred in parts. F. A. Lucas, U. S. National Museum, Washington, D. C.

WANTED.—Vols. I and II of Proceedings of the Entomological Soc. of Pha. and Vols. III to VI inclusive of Transactions of the American Entomological Soc. C. P. Gillette, Ft. Collins, Colo.

Wanted.—Sachs's Text-book of Botany, 2nd English edition. Dr. Alfred C. Stokes, 527 Monmouth Street, Trenton, New Jersey.

WANTED to exchange for human bones or recent medical text-books, the following books "Metallurgy of Silver," M. Eissler, 1889; "Practical Treatise on Petroleum," by Benj. J. Crewe, 1887; "Cook's Chemical Philosophy," 1885; "Cairn's Chemical Analysis," 1880; "Wagner's Chemical Technology," by Crookes, 1886; "Fresemier's Qual. Chem. Analysis," 1879; "Elementary Treatise on Practical Chemistry and Qual. Analysis."—Clowes, 1881; bound Vols. 1 to 12 of Dr. Lardner's "Museum of Science and Art" (very rare), 1854; back numbers of "Electrical World," beautiful specimens of Pyrite Incrustations from Cretaceous of New Jersey; Magnetis Iron Ore, Highly Polarized. Address D. T. Marshall, Metuchen, N. J.

WANTED.—Books or information on the microscopical determination of blood and hair. Also reports of cases where hair has played an important part in the identification of an individual. Address Maurice Reiker, 206 N. First Ave., Marshalltwn, Iowa.

A GEOLOGIST thoroughly conversant with the geology of the Southern States desires an engagement. Has complete knowledge of the economic geology of Iron, Coal, Lignite, as well as Clay and Kaolin. Five years' experience with Geological Surveys. Address K., 509 West Sixth Street, Austin, Texas.

WANTED.—Tuckerman's Geneva Lichenum and Carpenter on the Microscope, Wiley's Introduction to the Study of Lichens. State price and other particulars. Richard Lees, Brampton, Ont.

NEW METHOD OF PROTECTING BUILDINGS FROM LIGHTNING.

SPARE THE ROD AND SPOIL THE HOUSE!

Lightning Destroys. Shall it be Your House or a Pound of Copper?

PROTECTION FROM LIGHTNING.

What is the Problem?

In seeking a means of protection from lightning-discharges, we have in view two objects,—the one the prevention of damage to buildings, and the other the prevention of injury to life. In order to destroy a building in whole or in part, it is necessary that work should be done; that is, as physicists express it, energy is required. Just before the lightning-discharge takes place, the energy capable of doing the damage which we seek to prevent exists in the column of air extending from the cloud to the earth in some form that makes it capable of appearing as what we call electricity. We will therefore call it electrical energy. What this electrical energy is, it is not necessary for us to consider in this place; but that it exists there can be no doubt, as it manifests itself in the destruction of buildings. The problem that we have to deal with, therefore, is the conversion of this energy into some other form, and the accomplishment of this in such a way as shall result in the least injury to property and life.

Why Have the Old Rods Failed?

When lightning-rods were first proposed, the science of energetics was entirely undeveloped; that is to say, in the middle of the last century scientific men had not come to recognize the fact that the different forms of energy—heat, electricity, mechanical power, etc.—were convertible one into the other, and that each could produce just so much of each of the other forms, and no more. The doctrine of the conservation and correlation of energy was first clearly worked out in the early part of this century. There were, however, some facts known in regard to electricity a hundred and forty years ago; and among these were the attracting power of points for an electric spark, and the conducting power of metals. Lightning-rods were therefore introduced with the idea that the electricity existing in the lightning-discharge could be conveyed around the building which it was proposed to protect, and that the building would thus be saved.

The question as to dissipation of the energy involved was entirely ignored, naturally; and from that time to this, in spite of the best endeavors of those interested, lightning-rods constructed in accordance with Franklin's principle have not furnished satisfactory protection. The reason for this is apparent when it is considered that the electrical energy existing in the atmosphere before the discharge, or, more exactly, in the column of dielectric from the cloud to the earth, above referred to, reaches its maximum value on the surface of the conductors that chance to be within the column of dielectric; so that the greatest display of energy will be on the surface of the very lightning-rods that were meant to protect, and damage results, as so often proves to be the case.

It will be understood, of course, that this display of energy on the surface of the old lightning-rods is aided by their being more or less insulated from the earth, but in any event the very existence of such a mass of metal as an old lightning-rod can only tend to produce a disastrous dissipation of electrical energy upon its surface,—"to draw the lightning," as it is so commonly put.

Is there a Better Means of Protection?

Having cleared our minds, therefore, of any idea of conducting electricity, and keeping clearly in view the fact that in providing protection against lightning we must furnish some means by which the electrical energy may be harmlessly dissipated, the question arises, "Can an improved form be given to the rod so that it shall a[illegible] in this dissipation?"

As the electrical energy involved manifests itself on the surface of conductors, the improved rod should be metallic; but, instead of making a large rod, suppose that we make it comparatively small in size, so that the total amount of metal running from the top of the house to some point a little below the foundations shall not exceed one pound. Suppose, again, that we introduce numerous insulating joints in this rod. We shall then have a rod that experience shows will be readily destroyed—will be readily dissipated—when a discharge takes place; and it will be evident, that, so far as the electrical energy is consumed in doing this, there will be the less to do other damage.

The only point that remains to be proved as to the utility of such a rod is to show that the dissipation of such a conductor does not tend to injure other bodies in its immediate vicinity. On this point I can only say that I have found no case where such a conductor (for instance, a bell wire) has been dissipated, even if resting against a plastered wall, where there has been any material damage done to surrounding objects.

Of course, it is readily understood that such an explosion cannot take place in a confined space without the rupture of the walls (the wire cannot be boarded over); but in every case that I have found recorded this dissipation takes place just as gunpowder burns when spread on a board. The objects against which the conductor rests may be stained, but they are not shattered.

I would therefore make clear this distinction between the action of electrical energy when dissipated on the surface of a large conductor and when dissipated on the surface of a comparatively small or easily dissipated conductor. When dissipated on the surface of a large conductor,—a conductor so strong as to resist the explosive effect,—damage results to objects around. When dissipated on the surface of a small conductor, the conductor goes, but the other objects around are saved

A Typical Case of the Action of a Small Conductor.

Franklin, in a letter to Collinson read before the London Royal Society, Dec. 18, 1755, describing the partial destruction by lightning of a church-tower at Newbury, Mass., wrote, "Near the bell was fixed an iron hammer to strike the hours; and from the tail of the hammer a wire went down through a small gimlet-hole in the floor that the bell stood upon, and through a second floor in like manner; then horizontally under and near the plastered ceiling of that second floor, till it came near a plastered wall; then down by the side of that wall to a clock, which stood about twenty feet below the bell. The wire was not bigger than a common knitting needle. The spire was split all to pieces by the lightning, and the parts flung in all directions over the square in which the church stood, so that nothing remained above the bell. The lightning passed between the hammer and the clock in the above-mentioned wire, without hurting either of the floors, or having any effect upon them (except making the gimlet-holes, through which the wire passed, a little bigger), and without hurting the plastered wall, or any part of the building, so far as the aforesaid wire and the pendulum-wire of the clock extended; which latter wire was about the thickness of a goose-quill. From the end of the pendulum, down quite to the ground, the building was exceedingly rent and damaged. . . . No part of the aforementioned long, small wire, between the clock and the hammer, could be found, except about two inches that hung to the tail of the hammer, and about as much that was fastened to the clock; the rest being exploded, and its particles dissipated in smoke and air, as gunpowder is by common fire, and had only left a black smutty track on the plastering, three or four inches broad, darkest in the middle, and fainter towards the edges, all along the ceiling, under which it passed, and down the wall."

One hundred feet of the Hodges Patent Lightning Dispeller (made under patents of N. D. C. Hodges, Editor of *Science*) will be mailed, postpaid, to any address, on receipt of five dollars ($5).